VOLUME XII. NUMBER 3

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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PUBLISHED MONTHLY

March. 1918

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.
FOREIGN AGENTS: WILLIAM WESLEY & SON,
28 ESSEX ST., STRAND, LONDON.

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Subscription to the *Journal* is included in membership fee.

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ASTRONOMY: A CULTURAL AVOCATION

BY ALBERT DURRANT WATSON

RETIRING PRESIDENT'S ADDRESS, ANNUAL MEETING, JANUARY 29, 1918

"The old lost stars wheel back, ...
That blaze in the velvet blue;
They're God's own guides on the long trail—
The trail that is always new."

CHILD of the universe, compounded of dust, air and ether, with a heart that thrills to the song of the morning stars and eyes that see them shimmer over the moon-silvered sea, what is more natural than that man should be an astronomer?

Twenty years ago, an old friend told me that he had lost interest in the telescope and had turned instead to the microscope. I notice that recently, despite increasing years, he is again interested in astronomy. His experience is a common one. There are stages of education when one needs to pass on to new phases of the subject in hand. Failing to do this, one loses interest. My friend had lost his enthusiasm for the game of the tyro and needed to go on to the study of laws and forces. He cared no more for the puzzle of the midnight map,—the curiosity to find the centres and outposts in the star-fields of the sky.

Astronomy is the most simple of all the sciences. Current research, however, is showing it comprehensive enough to consume the leisure of a life, and suggestive enough to tangle in its meshes the tentacles of every other movement, whether it be in science, art, philosophy, religion, commerce, or enterprise. So true is this, that no great thing can be greatly done on earth whose doing is not oriented with the stars. Time and space, theory and practice, systems and details, methods, institutions and customs must all, here or elsewhere, now or sometime, touch and reckon with the sky.

No ship ever crossed the sea that did not climb along the stars. No tower, monument, or wall was ever built to stand and stay whose permanence was due to any other cause than its own inherent response, and that of its builders, to the one central law under which "the heavens were made by the word of His power."

The earth itself is a world near the centre of a system of stars, and every operation on its surface is directed, however subtly, under the governmental program of that system. All which goes to show not only that "the undevout astronomer is mad," but also that he who fails to acquire a reasonably accurate knowledge and appreciation of astronomy, in a general sense at least, has no valid claim to be considered as an educated person. He has neglected one of the chief essentials of education, and, as a result, lacks an effective cultural instrument in the field of imagination and other intellectual processes. He must, therefore, be defective in his appreciation of both religion and science.

Education, to be graced with the distinction of true culture, need not comprise a particular knowledge of all the sciences, but should, if it would rise to such a distinction, command a general view of each great department of knowledge.

But of all the sciences none is so essential to such a characterization as astronomy. It is not merely, in a literal sense, the loftiest of the whole circle of the sciences. The awful sweep of its majestic motions, its serene and absolute order, the simplicity and wonder of its laws, the blazing splendor of certain of its

objects, and still more, the restraint with which the true astronomer regards the unspeakable sublimities of his science, all go to make star-law the first in importance of all those agencies which give the human mind its glory and vision in a field so vast that we may never know its boundaries.

It becomes necessary, therefore, to acquire, at least, a general knowledge of this science, or else relinquish all claim to a culture the chief elements of which are clear vision and a serene poise that rises superior to the pettiness of these common aims and pursuits which characterize the consciousness and occupy the time of most of the human race.

The physicist realizes, especially in recent years, that there are facts outside the realms of gross matter quite as real and dependable, though far more subtle and elusive in some cases, as those observed by the five senses. The same is true of the astronomer. He too finds abundant exercise for his powers in fields of light and law, sharing with the physicist his problems of heat and radio-activity, of electric and magnetic forces, of relativity and other spatial subtelties, of hypotheses as to atmosphere and ether, color, light and sound. The physicist cannot possibly be an efficient physicist without being also something of an astronomer; neither can the astronomer be a thorough astronomer without being also a careful physicist.

But the co-ordination of the sciences does not stop here. Both the astronomer and the physicist are allured into fields beyond the boundaries of their respective sciences; so also the chemist, the biologist, the psychologist and the ethicist. No specialist can lay claim to a liberal culture in any sense without a comprehensive view of all the sciences. Such a culture will be sufficiently generous to preclude that prejudice which the specialists in one field of science too often manifest against the results obtained in another field by methods quite as strictly scientific as those employed by themselves in their own departments.

Such a prejudice has prevailed in their past between the physicist and the philosopher. We have had controversies, not always in the scientific spirit, which is always hospitable to facts

ascertained by carefully safeguarded methods. We have been wearied by conflicts between science and religion, materialistic on the one hand, superstitious on the other; traditional religion entrenched against an insurgent science, both crudely conservative, or both narrow in vision and devoid of philosophical insight.

Too often the empty husks of thought have been used as buttresses of a conservatism from which the vital energy and living fire have long since fled, while almost as invariably, the new theory with its vivid enthusiasm is so swaddled in the crudest wrappages that the prejudices of the learned against it are almost to be condoned.

What is needed in this situation is a more general knowledge and appreciation of those canons of research which the most thorough and effective science has always maintained, and especially such as are chiefly observed by the astronomer. The careful observer in any field of research never regards a theory as more than an hypothesis unless accumulated evidence has broken down and cleared away all other and opposing theories.

The most fatal enemies of all newly acquired knowledge are those who, regarding themselves as its friends, formulate a new generalization from insufficient data, state it as a creed or a law, and straightway regard all who do not accept it as enemies of progress.

These pseudo-scientists are stout defenders of their theories. To them the "law" is all-important; the facts are treated lightly. One may at any time find them measuring and modifying their facts, ignoring those that do not fit their theory, imagining or supplying others that do, abating or enhancing the data in their eagerness to prove their theories true. They leap at once from their conviction as to the existence of a new force to a theory of its nature and purpose. The frailest possible chain of evidence is sufficient to prove what they are already convinced is true, and straightway their problem is solved.

Henceforth, their whole task is to bring new facts to *prove* that the problem is solved. This method is opposed to all the

basic principles of scientific procedure. It opens the theory in question to the reasonable antagonism of all careful investigators. It invites ridicule. This is interpreted as persecution. Every weak cause needs martyrs. A strong cause never needs anything but honest investigation of the facts. A superstitious church needs martyrs. Every pseudo-science needs martyrs. Every inadequate hypothesis needs martyrs. But the theory that the earth revolves around the sun never needed martyrs; it needed careful and honest investigators.

The study of astronomy, quite as much if not more than that of any other science, teaches us to avoid such loose methods, and saves us from results so open to suspicion. Almost the whole world had accepted the nebular theory, but the astronomers still regarded it as an hypothesis. Now we have new theories advanced to explain the same or similar facts. These are winning favor, and must stand together with the older hypothesis and win whatever measure of support the facts may warrant. This is the scientific method. This is the astronomical method. It saves us from results so open to suspicion, so worthy of disregard if not even of a measure of contempt.

If the easy acceptance of theories supported only by facts selected by partisans is to be deprecated, so also, and even more, should we be on guard where prejudice against innovation is concerned. We know and see but in part. It is clear, therefore, that, in the long run, the progressive mind and heart will behold all things made new. Margaret Prescott Montague, in the *Atlantic Monthly* of May, 1917, tells how, for about twenty minutes, she once saw her whole life-setting in a new and infinitely more glad and radiant light. Her eyes were opened and she knows that reality is far finer and more glorious than she had ever dreamed.

The expectant attitude towards new aspects and expressions of truth greatly helps progress. Is this not, indeed, that faculty in the artist which we call susceptibility,—an onrush into new fields of thought—that attitude in the soul of nature itself which we term creation, but fail to identify with our own faculty, dif-

ferent only in degree, of originality. Essentially, Creation is originality, and originality is creation, and both are divine.

Before astronomy was a science, the influences of the stars had already made human faith simpler and human hearts more kind. Thus, of many star myths cherished by our aboriginal predecessors on this continent is one in which a star was said to have loved a beautiful maiden and to have shone awhile each evening where she could gaze upon it ere her eyes closed in joyous and refreshing sleep, for she also loved the star. But one day, in the blinding light, her celestial lover lost all trace of her and could not find her again though he sought for her all round the world every day.

In the final judgment we are all young, and our childlike hearts are led to hope that it became possible for this love-lonely star to assume the heroic guise of some adventurous voyageur, and, in such a capacity, to seek and find the beloved maiden in the form of a fairy princess, the elfin child of some great Algonkian chieftain, to glorious womanhood grown, and that they together explored the vales of the Peace River, the Athabasca, and even the Mackenzie, before Henry or Sir Alexander Mackenzie had opened those territories to our commerce.

The astronomical myths of our own land are not peculiar in the fact that they lend a subtle and poetic fancy to our dreams. Every nomadic race throughout time has had a purer religion and a more perfect poetry because it gazed much upon the heavens, and, with that chief faculty of religion which we call imagination, heard the morning stars chant their orisons to the soul of all who hides within the dawn, and comes forth again in dream when the deep billows of the dark roll up the east, releasing the great white armies of the sky.

We cite only one foreign example. Every one knows how a star is believed to have led three sages from far eastern deserts to the city of peace wherein the glorious Prince of Peace was to be born.

If the pre-scientific contemplation of the stars had an effect so salutary upon those who made them their friends, how much

more should the comprehensive and accurate research of modern astronomy develop those who are the subjects of such sublime and happy inspirations!

It is not easy to perceive how the workers in any field could easily escape a realization of the cultural value of this science. And yet, too often we learn its importance only by tragedy resulting from ignorance of the subject. We are told that many of our brave young soldiers were buried in foreign lands because they were ignorant of the face of the sky, and we know that all who ever travel in the night are to some extent at the mercy of their knowledge or ignorance of the starry vault that enarches them.*

It is a chief characteristic of all ignorance not to know the importance of the truth of which it is not aware. Lack of knowledge is not only an eclipse of vision, it is an occultation of the mind and heart, so that it not only does not see; it does not know there is anything to be seen. What it does see, it distorts and misinterprets, destroying it as a cultural force. An accurate view of even a fractional portion of such a subject as astronomy brings the whole life into a different focus so that the temple of thought gets a truer orientation.

This larger, truer vision more than suggests that if the physical universe is so extensive that we cannot think beyond space, then also the realm of laws and forces, and their appreciation in thought and feeling within the bounds of our consciousness, must, in all probability, be equally infinite.

As the intellect transcends the brain, giving the mind a magisterial relation to its own chief organ, so among the cruder materials of science, with a sense of mastery and mystery, we investigate forces and their causes, and realize our intimate relationship with the Fountain of Law, feeling that the mind that

*The thought uppermost in the mind of Mackenzie returning from the Arctic was not pride in the deed accomplished, but a realization of his limitations in astronomical knowledge. He would go back to Britain and study the stars for a time instead of skins, planets for peltries.—Agnes Deans Cameron, *The New North*, page 353.

understands and loves is not so very far in essence from that overmind which functions and expresses its being through the phenomena of nature.

We cannot measure all the final forces that lie behind the expressions of law in the physical world, but we can measure their immediate effects. Thus we do not feel as strangers in a world whose seas run ringing up their coasts responsive to the sway of the moon, for we too feel the moods and tenses of the night, and know and feel the presence of that Good Shepherd who

"Bids the stars perform their shining"

and leads the constellations like flocks of sheep along the meadows of the sky.

Thus the thought, feeling and high purpose of life are re-tuned to the music of a vaster chord. Life and the vision of life are enlarged as a result, and greater and higher achievement is inspired when a more accurate view is attained of one smallest segment of the circle of science in this field.

Preconceptions and prejudices arising out of a limited vision result often in real disaster. To misinterpret motives is one of the commonest mistakes, and a source of many moral and social tragedies. When the illuminating and restraining influence of a cultural training gives a better estimate of the motives of others, misunderstanding is ended, the vision grows clearer, and patience and sympathy become almost sublime under the ægis of a science so vast in its reaches and, in its varied fields, so diverse in its conclusions.

Not only do we thus avoid misunderstanding others, we are led also to a better understanding of our own being. Few of us realize as did the ancient Greeks, how central and vital is such knowledge, and how rare.

We constantly misinterpret ourselves in life and conduct. Almost always we underestimate our own intrinsic worth while we grossley overestimate our achievement. We fail to realize our high cosmological station in the great family of life, as elements in a universal race, yet we so grossly over-value ourselves

in comparison with others that, with their larger vision and more accurate conception of relative values we must afford laughter to the gods. We have a very erroneous idea of our own relativity.

Such defects could have no better curative remedy than that furnished by the thoughtful investigation of star-laws and relations. It is true that a first thoughtful glimpse of the immeasurable universe is liable rather to discourage us with a sense of our own insignificance. But astronomy is wholesome even in this, and helps to clear the way to a realization that as our bodies are an integral part of the great physical universe, so through them are manifested laws and forces that take rank with the highest manifestation of Cosmic Being.

Thus we come to see that if our bodies are made of star-stuff, —and there is nothing else, says the spectroscope, to make them of—the loftier qualities of our being are just as necessarily constituents of that universal substance out of which are made

"Whatever gods there be."

We are made of universal and divine ingredients, and the study of the stars will not let us escape a wholesome and final knowledge of the fact.

The corollary is that all our conduct, ambitions and aspirations should have a universal quality. How does our daily life look in the universe? Are we behaving as divine-human beings should? Would any one know from our achievement, even when we call it success, that we are Olympians? Such questions are suggested, not theologically, nor as arising out of any particular system of religious thought, or teaching, or practice, but purely and logically by our outlook as astronomers. We are prompted to choose the wide vista, the high purpose, the great effort, leaving to others the plaything of success, while we, conscious of the universe and its forces, move on in our robes of serenity, our eyes telling the story of our far deep vision of reality.

Perhaps, the most conspicuous failure of our lives, as understood by the keen, clear insight of the seer, is found in that veil

of self-consciousness which hides this same reality from human eyes. Sooner or later, we all see this veil and deplore its paralyzing and blinding effects in our lives, with all the disaster — note the starry word — and confusion which it entails. So vast is this dislocation, this deformation of our intellectual landscape, that constant re-adjustment of our viewpoint becomes necessary with frequent rehabilitation of our modus and our credo.

This veil of self-consciousness which lies before reality is probably after all only an evidence that our hearts are young and, therefore, fearful in the strange vastness of an unfamiliar home. Man has not learned as yet to comport himself effectively in the midst of the universe, and his lack of skill makes him self-conscious. The mass of things appals him ; the activity of so many forces makes him feel helpless in their presence.

We have constructed myths that frighten us with gargoyle heads and leering faces. Meanwhile of all those enlightening agencies that give us a higher altitude and wider vista, none is more effective than that noble science which we celebrate tonight.

Astronomy, by giving a fixed station to eras and events, becomes the final arbiter of time. Cut human experience lengthwise and time is the result. Astronomy measures the length of its various parts, thus making possible an orderly and intelligent view of history.

Astronomy is also a measure of space. The astronomer forgets your kilometers and reaches out to sun-distances and light-years. Here is a science that will lift its votaries out of the world of appearances and make of them poets and statesmen, artists and philosophers, setting them in a new world of contemplation and reverence, or wafting them onward over "a light-sea of celestial wonder."

Once the heart feels at home in the universe, the mind becomes incapable of fads. Other influences may have a similar effect, but the contemplation of star-law does most surely help one to recognize and avoid those shibboleths that estrange individuals and breed discord among races. I am persuaded that

no true astronomer would hang fate and the future on a text. In the olden time, when one was asked concerning "the antichrist," the answer was: "Even now there are many of them." When a still greater was asked if Elijah would come at a certain juncture, he answered wearily: "Elijah has come already!"

This spacious view of life and nature lifts us above our vulnerabilities. When the eye catches a glimpse of a nebula thousands of light-years away, self dwindles to a vanishing point. Nevertheless, the contemplation of the generous proportions of this vast home in which we dwell makes us realize at last, that we, who are inhabitants of mansions of beauty and sublimity beyond our conception, must be, in our essential being and, therefore, in the illimitable promise of our future progress and achievement, far nobler than we have ever dared to dream.

Such is the science to which we invite your attention; such the path into which we seek to entice your feet. Should you consent to enter that highroad, we feel sure that you will not return from your explorations and say: "I find the sky smaller and cruder, less interesting, significant and inspiring than you had led me to expect."

But with a heart pulsating to the rhythm of invisible forces, a soul attuned to the music of the great sphere-harmonies, and vision focussed to the fine definition of immeasurable reaches, we shall scrap our impedimenta, brush circumstances aside, ignore appearances that deceive only the blind of heart; and going forth blithely on highroads of reality, shall never again be petty or puerile, or fall below the demands of our own imperial purpose.

Realizing that Life has caught this earth in the train of its trailing splendors, we shall see how fondly we have seized earth-things, clinging to them as a child to its toys; we shall observe that Life sweeps everything it needs into its own great repertoire and bends them to ends of progress and power, but abandons to convenient gehennas all that is not real, all that is merely handicap,—a drag on its lofty wing.

THE ORBIT OF THE SPECTROSCOPIC BINARY BOSS 3138

By J. B. Cannon

BOSS 3138, ($\alpha = 11^h\ 55^m\cdot8$, $\delta = -19°\ 6'$; mag. 5·28, type *B*3), was announced a spectroscopic binary by Adams from four plates giving a range of 201 km. (*Astrophysical Journal* XXXV., 176). The lines of the spectrum are very poor, and its declination being far south it was difficult to secure good plates and more difficult to secure plates when wanted. The determination of the orbit was based on 31 plates taken in the last two seasons. The period being almost exactly a day and a half had a tendency to bunch the observations at certain points in the orbit. It will be seen by the velocity curve that the residuals of the normal places are high at points near the zero velocity line. This is due, no doubt, to the other component. On several of the plates there was a suggestion of doubling in some of the lines although never distinctly enough seen to make the weaker component measurable. Plate residuals are high, but considering that on some plates the velocities given by different lines vary to the extent of as much as 70 km., high residuals are to be expected.

The 31 observations were grouped into nine normal places as follows:

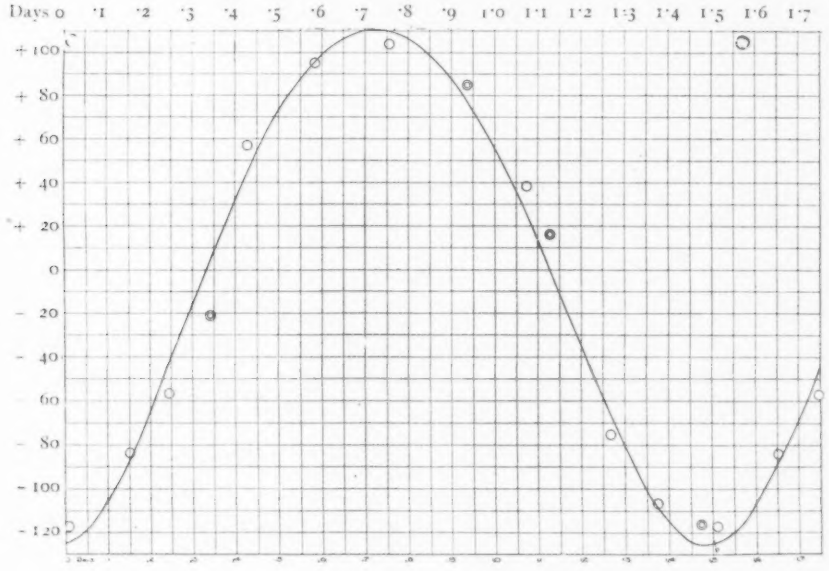
Normal Places

No.	Julian Day	Phase	Velocity	Wt.	Residual
1	2,421,104·371	1·073	+ 38·3	1	+ 12·4
2	247·304	1·266	− 75·5	2	− 8·2
3	078·062	1·373	− 106·5	1·4	+ 2·1
4	2,420,958·769	0·007	− 117·1	2	+ 7·7
5	2,421,291·348	0·150	− 84·0	1·7	+ 4·5
6	091·670	0·244	− 56·8	2	− 11·8
7	100·780	0·429	+ 57·0	1·5	+ 12·1
8	026·750	0·584	+ 95·0	2	− 0·2
9	287·502	0·756	+ 104·0	1·4	− 6·2

By using the Mt. Wilson observations in conjunction with our own the period was determined with considerable accuracy, *viz.*, – 1·50307 days. The other elements of the orbit were obtained by Dr. King's method. They were:

$$K = 115 \text{ km.}$$
$$e = \cdot 05$$
$$\omega = 195$$
$$T = \text{J.D. } 2{,}420{,}917\cdot 601$$
$$\gamma = -1\cdot 45 \text{ km.}$$

One least squares solution was carried through, the value of the period being taken as fixed and omitted from the solution. The resulting corrections are small but the value of Σpvv was reduced about 30 per cent. The corrected values of the elements are given below with the probable errors appended.



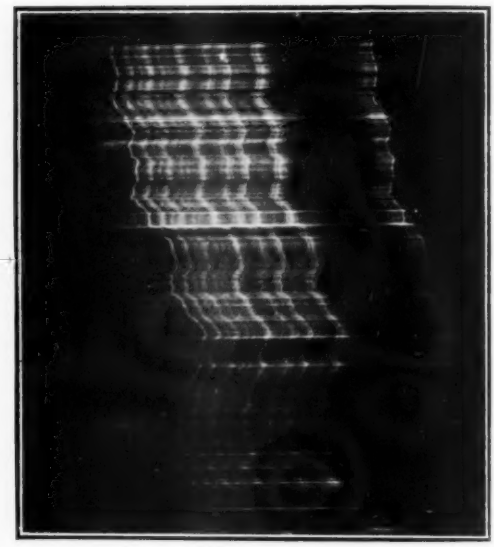
RADIAL VELOCITY CURVE OF BOSS 3138

K	= 118·19 km.	± ·80 km.
e	= ·078	± ·0082
ω	= 185°·08	± 9°·54
T	= J.D. 2,420,917·573.	± ·038 days.
γ	= + 1·70 km.	± ·72 km.
P	= 1·50307 days	
$a \sin i$	= 2,435,000 km.	
$\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$	= ·25 × sun.	

Probable error of single plate = ± 13 km.

DOMINION OBSERVATORY,
OTTAWA, CANADA
June, 1917

PLATE I.



SPECTRUM OF LIGHTNING, PHOTOGRAPHED BY A. STEADWORTHY, DOMINION ASTRONOMICAL OBSERVATORY, OTTAWA.

A NOTE ON THE SPECTRUM OF LIGHTNING

By J. B. Cannon

SINCE the publication of Slipher's article on "The Spectrum of Lightning" (*Bulletin* 70, Lowell Observatory Publications) which showed the close agreement of the wave-lengths of the lines of the spectrum with those of the air spectrum as determined by Neovius, it was thought it might be worth while remeasuring the spectrum obtained here, on which an article appeared in the Journal of the Royal Astronomical Society of Canada, September-October, 1914. The wave-lengths given there were computed from measures made by means of a millimeter scale used on a highly enlarged print. It was thought that better results might be obtained by using a reduced negative on a measuring engine. This was done and although fewer lines were measured, they are, undoubtedly, more accurate. Also the wave-lengths of the standard lines used were taken from Neovius's values of the air lines and this, no doubt, contributes to greater accuracy.

A second spectrogram was obtained by Mr. Steadworthy and has also been measured. It was measured twice at two different points and the mean is given in the table below. The great difficulty in the measuring of lightning spectrograms is finding a point where the lines are perpendicular to the direction of the motion of the carriage on the engine, so that the spider line may bisect the line evenly, instead of slanting across, making it necessary to balance up parts above and below a central point. Also the amount of light which has come through so fogs the plate that many lines are spoiled for measuring. It must be remembered that these plates were taken without a slit, and those familiar with spectrograms will understand the great disadvantage in this.

Some parts of the spectrum show lines which do not appear

at other parts. In all cases the main lines show and are easily identified but many of the faint lines may or may not appear and the weight attached to them will give an idea of their faintness. When seen through the microscope they appear merely as a slightly more darkened part of the emulsion and only for the fact that they are traceable elsewhere, otherwise they might be considered as imperfections in the plate.

The first column contains wave-lengths of lines in the air spectrum; the second, our measures of spectrum I (L I); the third, measures of spectrum II, (L II); fourth and fifth, the residuals of L I and L II, (R I and R II); and sixth, Slipher's wave-lengths.

Air	L I	Wt.	L II	Wt.	R I	R II	Slipher
3831·0							3830·6
3839·8							3838·0
3850·6							3851·0
							3869·4
3882·8							3882·2
3893·4	3893·2	1			− ·2		3892·4
3912·2							3913·1
3919·2	3919·1	½	3920·0	½	− ·1	+ ·8	3918·8
3939·7							3941·0
3946·4	3946·3	1	3945·9	1	− ·1	− ·5	3947·3
3955·4	3955·0	1	3955·3	1	+ ·2	− ·1	3955·2
3973·5			3972·7	½		− ·8	3973·0
3995·2	3995·2	9	3995·2	9	0	0	3995·2
4011·1							4013·0
4025·9	4024·5	½			− 1·4		4025·2
4035·2							4034·9
4041·5	4041·4	5	4040·2	3	− ·1	− 1·3	4041·8
							4055·8
4072·9			4072·2	2		− ·7	4072·8
4097·3	4098·3	2	4099·1	1	+ 1·0	+ 1·8	4099·3
4105·8	4109·2	5	4109·8	2	− ·6	0	4109·4
							4120·0
4133·6							4132
4144·9	4145·0	2	4145·3	1	+ ·1	+ ·4	4141·2
4152·8	4152·6	5	4153·5	3	− ·2	+ ·7	4152·2
4170·7			4171·7	½		+ 1·0	
4176·7	4177·8	½			+ 1·1		4176·1
4197·3							4198·1
4215·6							4216·4
4224·2	4224·0	5	4224·3	1	− ·2	+ ·1	4225·7
			4231·3	2			
4237·0			4236·8	1		− ·2	

Air	L I	Wt.	L II	Wt.	R I	R II	Slipher
4239·5	4240·3	1			+ ·8		4238·6
4254·1	4254·3	2			+ ·2		4254
4266·7	4265·5	½			- 1·1		4266
4272·5							4276·8
4318·5			4319·5	1		+ 1·0	4318·2
	4340·9	1					
4348·7	4348·5	1	4347·6	3	- ·2	- 1·1	4347·5
	4356·8	1					4357
4369·2	4368·2	5	4369·3	1	- 1·0	+ ·1	4368·7
4398·7							4397
4416·2			4415·3	3		- ·9	4416·4
4428·0			4428·7	½		+ ·7	
	4432·4	½					4431·8
4447·3	4447·3	6	4447·3	7	0	0	4446·9
4483·0	4465·0	1					4483
	4491·8	1					
4507·7							4509
4530·3	4530·9	2			+ ·6		4530·6
4552·6	4552·3	½			- ·3		4551·7
4604·3	4602·7	2	4603·2	3	- 1·6	- 1·1	4605·2
4630·9	4631·1	6	4630·6	6	+ ·2	- ·3	4630·8
4642·7	4642·3	3	4643·2	2	- ·4	+ ·5	4643·3
4668·1			4668·5	½		+ ·4	
4672·6	4672·1	½			- ·5		4672·4
4675·6			4674·3	1		- 1·3	
4696·9			4696·2	½		+ ·2	
4699 7							4700·6
4784·3							4783·2
4804·9							4804·6
4861·0			4860·2	½		- ·8	4861·3
4935·1	4938·3	2			+ 3·2		4933·6
5004·2	5004·2	9	5004·2	5	0	0	5003·5
5172·5			5173·6	1		+ 1·1	
5180·6			5180·1	½		- ·5	
5496·6			5496·6	1		0	
5530·4			4531·2	2		+ ·8	
5576·0	5575·5	1			- ·5		
	5625·3	1					
5677·9	5678·4	8	5675·8	7	+ ·5	- 2·1	
	Arithmetical Mean				0·6	0·6	
	Algebraical Mean				- 0·03	- 0·06	

Dominion Observatory,
Ottawa, Canada.

MEETINGS OF THE SOCIETY

ANNUAL GENERAL MEETING.

The Annual General Meeting of the Society was held in the Society's Rooms, 198 College St., Toronto, January 15, 1918. The President, Dr. A. D. Watson, in the chair.

Moved by Dr. Chant and seconded by Mr. Hunter, that the minutes of the last Annual Meeting as printed in the Journal be taken as read and approved. Carried.

The General Secretary's Report for 1917 was presented. Moved by the Recorder, that the Secretary's Report be received and adopted. Seconded by Prof. Chant. Carried.

Moved by Prof. Chant, seconded by Mr. Sparling, that the President name scrutineers to count the ballots for annual election. Carried. Mr. Z. M. Collins and Mr. Wallace were appointed scrutineers.

The Librarian's Report for 1917 was presented.

The Editor of the Journal made a brief report, including some complimentary references received by the Journal from various sources.

Moved by Mr. Hunter, seconded by Mr. Sparling, that the Librarian's and Editor's Reports be adopted.

The General Treasurer's Report for 1917 was received. Mr. Hunter and Dr. Fraser, auditors, reported that the Treasurer's accounts for 1917 were found correct.

Moved by the Treasurer, seconded by Prof. Chant, that the Treasurer's Report be adopted. Carried.

The scrutineers reported the following officers were elected for 1918:—

Honorary President—J. S. Plaskett, B.A., D.Sc.
President—A. F. Miller.
First Vice-President—J. R. Collins.
Second Vice-President—Otto Klotz, LL.D., D.Sc.
General Secretary—W. E. W. Jackson, M.A.
Treasurer—Chas. P. Sparling
Recorder—A. F. Hunter, M.A.
Librarian—C. A. Chant, Ph.D.
Curator—Robt. S. Duncan.
Council—Rev. I. J. Kavanagh, M.A., D.Sc., Montreal.
Rev. Dr. Marsh, F.R.A.S., Pickering, Ont.
Sir Joseph Pope, K.C.M.G., Ottawa.
Stuart Strathy, Esq., Toronto.
John Satterly, M.A., D.Sc., Toronto.
Dr. W. M. Wunder, Toronto.

These, with the Past Presidents and the presiding officers of each Centre constitute the General Council of the Society.

A motion was moved and carried that the thanks of the Society be tendered to the scrutineers and auditors for their services.

The Meeting then adjourned.

W. E. W. Jackson,
Recorder.

The General Secretary's Report for the year 1917 is as follows:—

Regular meetings have been maintained during the year, at Toronto, Ottawa, Hamilton, Winnipeg, Regina and Victoria.

Fifteen regular meetings have been held at Toronto; thirteen at Ottawa; six at Winnipeg; four at Guelph; four at Victoria.

Notwithstanding the great stress of the war, the interest in the meetings has been very well sustained throughout the year.

Many of our members are serving the allied cause overseas and several have fallen.

The total membership in the Society now numbers 368.

The Secretarys' Report from Ottawa, Winnipeg and Guelph are attached. These are the only Reports from outside Centres that have been received.

J. R. COLLINS,
General Secretary.

The Secretary's Report from the Victoria Centre was received too late for presentation to the Annual Meeting, but is attached for publication in the Journal.

Mr. E. A. Hodgson, M.A., Secretary of the Ottawa Centre, reported as follows:—

During the year thirteen meetings were held, including the Open Air Meeting held on June 2nd. The other evening meetings were:—

"Canada's Great Reflecting Telescope." By Dr. J. S. Plaskett.

"Time and Clocks." By Mr. R. M. Stewart, M.A.

"Is the Climate Changing?" By Sir Frederic Stupart.

"The Moon." By Dr. R. G. Aitken.

"Longitude Observations in the Peace River District." By Mr. F. A. McDiarmid, M.A.

"Early Surveying Trips in the Canadian West and Alaska." By Mr. J. J. McArthur, D.L.S.

The other meetings, which were held in the afternoon, were as follows:—

"Reminiscences of an Exploring Trip through the Yukon, along the base of the St. Elias Alps." By Mr. J. J. McArthur, D.L.S.

"Some Problems in Photography." By Mr. A. Steadworthy.

"Kindergarten Lessons in Practical Astronomy." By Mr. Thos. Fawcett, D.T.S.

"Triangulation along the New Brunswick and Maine Boundary." By Mr. J. L. Rannie, D.T.S.

"Photographic Photometry." By Mr. R. M. Motherwell, M.A.

"The Geodetic Comparator of the Surveys Laboratory." By Mr. G. B. Dodge, D.L.S.

The evening meetings were held in the Carnegie Library, with the exception of those by Dr. Plaskett and Dr. Aitken, which were both held in the Normal School. The afternoon meetings were held in the Geodetic Survey Building. The evening open air meeting was held at the Observatory.

We began the year with a membership of 77. During the year we have lost one member by resignation; four are recommended to be dropped from the list, and during the year there have been six new members elected, bringing the total membership to 78.

This year has been a memorable one for the Society, in that four of its members have been appointed to positions of marked responsibility and honor in science. These appointments are as follows:—

Dr. Otto Klotz, Chief Astronomer and Director of the Dominion Observatory.

Mr. J. J. McArthur, H. M. Boundary Commissioner.

Mr. Noel Ogilvie, Superintendent of the Geodetic Survey of Canada.

Dr. J. S. Plaskett, Director of the Dominion Astro-physical Observatory, Victoria, B.C.

The seven members mentioned in last year's report as being on active service are still at the front. Two at least have been wounded, but are back on duty. So far as is known there are no further casualties.

The election of officers resulted in the return of the entire Executive of last year, namely:—

President—J. J. McArthur.

Vice-President—C. A. Bigger.

Secretary—R. M. Motherwell.

Treasurer—D. B. Nugent.

Councillors—Dr. W. Bell Dawson, G. B. Dodge, Thos. Fawcett.

These, together with the Past Presidents, Dr. Klotz, Dr. Plas-

kett, R. M. Stewart, and F. A. McDiarmid, constitute the Executive of the Ottawa Centre for the year 1918.

The above constitutes the report of the Secretary for 1917. All of which is respectfully submitted.

J. W. Campbell, Ph.D., Secretary of the Winnipeg Centre, reports as follows:—

Since the last annual meeting on Dec. 13, 1916, six regular meetings of the Society have been held as follows:—

Dec. 13, 1916—"Motions of the Solar System, Eclipses, etc.," illustrated by rotating and colored slides. Mr. J. W. Harris, C.E., D.L.S., and Mr. C. E. Bastin, B.A.

Jan. 31, 1917—"Base Line Surveying in Northern Manitoba" (illustrated). Prof. G. H. Herriot, B.Sc., D.L.S.

Feb. 28, 1917—"Nebulæ" (illustrated). Prof. L. A. H. Warren, M.A., Ph.D., F.R.A.S.

Mar. 21, 1917—"The Planets" (illustrated). Mr. J. H. Kolb.

April 4, 1917—"The Calendar." Prof. J. W. Campbell, M.A., Ph.D.

Dec. 4, 1917—"Eclipses" (illustrated). Prof. L. A. H. Warren, M.A., Ph.D., F.R.A.S.

At the annual meeting held on Dec. 4th, the following officers were elected for the coming year:—

President—H. R. Kingston, M.A., Ph.D.

Vice-President—Mr. J. H. Kolb.

Secretary-Treasurer—Prof. O. T. Anderson, M.A.

Council—Mr. C. E. Bastin, B.A.; Mr. J. W. Harris, C.E., D.L.S.; Mr. Frank Powell; Mrs. Howey; Prof. L. A. H. Warren, M.A., Ph.D., F.R.A.S.; Rev. Father Blain, S.J.

John W. Charlesworth, Secretary of the Guelph Centre, reports as follows:—

The Annual Meeting of the Guelph Centre was held on January 7th. The following officers and Council for 1918 were elected:—

Honorary President—James Davison, B.A.
President—R. R. Graham, B.A., B.S.A.
First Vice-President—Lt.-Col. D. McCrae.
Second Vice-President—James McNiece, B.A.
Secretary-Treasurer—H. Westoby.
Recorder—J. W. Charlesworth, B.A.
Council—Mrs. J. J. Drew, Miss M. Mills, F. A. Graesser, Prof. W. H. Day, J. M. Taylor, Sr., Wm. Laidlaw, Col. A. H. Macdonald, H. J. B. Leadlay.

Mr. G. S. McTavish, Secretary of the Victoria Centre, reports as follows:—

The Annual Meeting of the Victoria Centre of the R. A. Society was held on January 25th, the elected officers for 1918 being as follows:—

Honorary President—Dr. J. S. Plaskett.
President—W. S. Drewry.
Vice-President—J. E. Umbach.
Secretary—G. S. McTavish.
Treasurer—J. P. Hibben.
Council—Messrs. K. M. Chadwick, Rev. Robert Connell, A. W. McCurdy, F. Napier Denison, T. C. Green, Dr. D. Young, and J. B. Shenton.
Auditor—Thomas Shotbolt.

This Annual Meeting should have been held in December, 1917, and the necessary information relating to the workings of the Victoria Centre forwarded to Toronto for the Annual Meeting of the Royal Astronomical Society. Unfortunately, owing to the unavoidable absence of the President, Vice-President and Secretary during the greater part of 1917, the Society has not reached its usual number of meetings, or been in a position to assemble since the last meeting on April 17th, till this occasion. The old motto of "Better Late Than Never" affords some consolation to the deferred activities of your executive officers, and this explana-

tion will, we trust, be accepted by the members as an apology for a seeming lack of interest in behalf of the Victoria Centre and that of the parent Society.

The following lectures are recorded in the Minute Book:—

Dec. 19th, 1916—"Weighing the Planets." A. W. McCurdy (Presidential Address).

Jan. 17th, 1917—"The Relation of Astronomy to Geology." Rev. Robt. Connell.

Feb. 20th, 1917—"Nautical Astronomy." Commander J. B. Shenton.

April 17th, 1917—"Some Phases of Astronomy." John Grice.

An Executive meeting was held on February 14th, 1917, at which Commander J. B. Shenton was appointed temporary Secretary, in the absence of the incumbent. Executive meetings were held at No. 1120 Government Street on the 18th and 22nd inst., in preparation for the Annual deferred meeting of December, 1917.

Membership.—There are 67 names on the roll appended. Thirty-four have paid their dues for 1917. Three paid arrears for 1915 and five for 1916. There are members on the Honorary List on Service, viz.: G. G. Aitken, P. S. Bethune, M. de Boyd, A. C. B. Gray, E. H. H. Harrison, Dr. L. F. Houghton, P. H. Hughes P. S. Langton, Capt. C. L. Roberts, F. C. Swannell, V. Schjelerup, T. T. White, F. Wollaston and Capt. H. S. Jarvis, serving on H.M.S. "Excellent." Mr. J. B. Mitchell, a former member, is reported "killed in action."

Grant.—The Dominion Government reduced the grant to the Royal Astronomical Society to one thousand dollars, the parent Society remitting us the sum of twenty-five dollars. The Treasurer's Report will show we have kept within the limit of our income. The appended memorandum, signed by Albert D. Watson, President, J. R. Collins, General Secretary, C. A. Chant, Editor, describe the requirements and utilities of the Society in a condensed yet comprehensive manner, and should be entered among our records.

Under adverse war and business conditions it is encouraging

to think we are doing our endeavors to keep alive the interests of the Victoria Centre. We have only to "stay with it" till brighter days (and brighter nights, in view of the advent of the new telescope) will reward our perseverance and faithfulness.

LIBRARIAN'S REPORT.

On account of the reduction in the Society's income the expenditure on the Library has been much smaller than usual. No binding has been done, and very few books have been purchased. However, it will hardly be possible to allow this starvation condition to be continued during the coming year.

As in previous years, the Library has continued to receive the chief astronomical periodicals and various other official publications, thus keeping complete many series. Most of these come in exchange for our own publications.

I would again urge the members, whether living in Toronto or outside of it, to make greater use of the Library. Our collection of books and periodicals is of great value.

The following statistics may be given:—

Number of periodicals received during the year....	
Published in Canada and the Empire	215
Published in the United States	255
Published in other countries	83
	553
Number of books presented to the Library....	8
Number of books purchased for the Library...	3
Number of books and periodicals borrowed....	98

C. A. CHANT,
Librarian.

The Treasurer's Report is as follows :—

FINANCIAL STATEMENT YEAR ENDING 1917

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

1917	RECEIPTS, 1917		
Jan. 1	Cash in Bank	$1592.81	
	Grant from Dominion Government	1000.00	
	Grant from Ontario Legislature	600.00	
	Grant from City of Toronto	100.00	
	Grant from University Library (for exchanges)	100.00	
	Interest on Bonds, etc.	67.10	
	Fees from Members	587.87	
	Dept. Astro Physics, for books	20.00	
			$4067.78

1917	DISBURSEMENTS, 1917		
Dec. 31	Publication of JOURNAL and HANDBOOK	1939.31	
	Public Meetings	64.00	
	Library for Books, etc.	80.24	
	Bank Charges on Cheques	2.96	
	Stationery and Postages	40.80	
	Slides for Lantern	2.00	
	Salaries, Asst. Librarian, Janitor	310.00	
	Rent of Rooms	200.00	
	Grant to Ottawa Centre	95.00	
	Grant to Hamilton Centre	25.00	
	Grant to Winnipeg Centre	25.00	
	Grant to Victoria Centre	25.00	
	Grant to Guelph Centre	25.00	
	Printing Account	35.70	
	Cash on hand in Imperial Bank	1197.77	
			$4067.78

Respectfully submitted,
CHARLES P. SPARLING,
General Treasurer.

Audited and found correct,
(Signed) A. F. HUNTER,
JOHN B. FRASER, M.D.
Auditors.
Toronto, January 15, 1918.

Attached are the Financial Reports received from the various Centres.

OTTAWA CENTRE

Financial Statement, 1917

RECEIPTS

Balance on hand	$ 14.41	
Grants from General Treasurer	95.00	
Interest	.34	
		$109.75

EXPENDITURES

Lectures	47.00	
Printing	42.68	
Use of Lecture Halls	8.00	
Postage	7.50	
Small items	1.25	
		$106.43
Balance on hand		3.32
		$109.75

Respectfully submitted,
D. B. Nugent,
Local Treasurer.

Examined and found correct.
(Signed) D. Robertson,
W. A. Dier.
December 14th, 1917.

GUELPH CENTRE

Financial Statement, Dec. 31st, 1917

RECEIPTS

Balance on hand Jan. 1st, 1917	$ 17.60	
Members' fees for 1917	40.00	
Arrears	2.00	
Grant from R.A.S.C. for 1917	25.00	
Interest on account in Royal Bank	.72	
		$ 85.32

DISBURSEMENTS

Remittance to General Treasurer as Members' Fees	$ 40.00	
Travelling Expenses of Lecturers	23.50	
Printing, Advertising and Postage	10.10	
Rent of Lecture Hall	6.00	
Caretaker of Hall	2.00	
Balance in Royal Bank	3.72	
		$ 85.32

James McNiece,
Local Treasurer.

Audited and found correct.
(Signed) James Davison.
Jan. 5th, 1918.

WINNIPEG CENTRE

Financial Statement, 1917

RECEIPTS

To balance on hand	$ 88.32	
" Fifteen 1917 subscriptions	30.00	
" One 1916 and one 1917 subscription	4.00	
" Grant from Toronto	25.00	
" Interest to date	2.91	
		$150.23

EXPENDITURES

By Remittances to Toronto	$ 34.00	
" Stationery	7.25	
" Exchange	.42	
" Balance on hand	108.56	
		$150.23

J. W. Campbell,
Treasurer.
per H. R. Kingston,
Treasurer, pro tem.

Audited Dec. 4, 1917, and found correct.
(Signed) G. H. Herriot,
L. A. H. Warren.

VICTORIA CENTRE

Financial Statement, 1917

RECEIPTS

Balance in Savings a/c, Bank of British North America	$ 26.51	
Dues:		
3—1915	$ 6.00	
5—1916	10.00	
20—1917	40.00	
	56.00	
Toronto Grant for 1917	25.00	
Bank Interest	2.19	
		$109.70

EXPENDITURE

Dues to Toronto R. A. Society:		
3—1915	$ 6.00	
5—1916	10.00	
20—1917	40.00	
	$ 56.00	
Postage stamps	2.00	
Janitor's Fees—Four meetings: Dec., 1916; Jan., 1917; Feb., 1917, and April, 1917, at $1.50	6.00	
Colonist Prtg. & Pblg. Co., printing notices	9.00	
J. Grice—Postal Note in abeyance	2.00	
Balance	34.70	
		$109.70

Respectfully submitted,
J. P. Hibben,
Local Treasurer.

Examined and approved.
(Signed) T. Shotbolt.
28th January, 1918.

ANNUAL "AT HOME" OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA.

The Annual "At Home" was held in the Society's Rooms, 198 College St., at 8 p.m., the President-elect, Mr. A. F. Miller, in the chair. There was a large attendance of members and their friends.

The Chairman welcomed the audience, especially those not members of the Society, and read the list of officers elected for the ensuing year.

The following were elected members:—

Capt. Jos. A. Pearce, D.S.O., 585 O'Connor Ave., Ottawa.
Dr. L. G. Pearce, Brantford, Ont.

Four nominations for membership having been received, on motion by Prof. Chant, seconded by Mr. J. R. Collins, it was resolved that, under the special circumstances, the by-law requiring two weeks' postponement of their election be suspended, and they were accordingly elected members, viz.:—

Charles Frederick Burden, Massey, Ont.
Henry A. McCharles, Lucknow, Ont.
J. P. Henderson, M.A., University of Toronto.
I. R. Pounder, M.A., University of Toronto.

The retiring President, Albert D. Watson, M.D., delivered an address on "Astronomy, a Cultural Avocation." He welcomed to the chair as President-elect, Mr. Allan F. Miller, who, while not a professional astronomer, has proved himself to be an able one.

Dr. Watson spoke of astronomy as the most simple of all the sciences; a person who has not learned astronomy lacks one of the most important departments of knowledge, and it therefore becomes necessary to acquire the general outlines of the science. Every specialist, whatever science he may follow, needs a general view of all the sciences. The canons of research are needed by all scientists to distinguish clearly theory and actual fact. He also spoke of the confidence the whole world places in the predictions contained in the Nautical Almanack, a circumstance which shows the established value of astronomical work. Every nomadic

race has been benefited by star-gazing; if, then, they had so much benefit, how much more can be learned at the present day by those who work with vastly more improved astronomical instruments. The fur trader in the days of early Canada, Sir Alexander Mackenzie, went home to Great Britain and studied astronomy, after which he again came to America and made his pioneer trip to the Pacific. Those who have observed the characters of astronomers have clearly seen the beneficial influence the study has had on them. Astronomy is also the final arbiter of time; it is likewise the ultimate measure of space, and gives a spacious view of life and nature.

The Chairman commended the broad view taken in the address, and conveyed the thanks of the audience, who were indebted to the author of it for its many inspiring thoughts.

Prof. Chant referred to the exhibits that had been placed on the walls of the rooms, especially the large photographs of the moon and the appartus to show the aberration of light. He had received from Mr. Andrew Elvins, just before the meeting, a telephone message expressing the good wishes of the sender, who will be ninety-five years of age next May.

Dr. Satterly explained his apparatus for showing aberration of light and showed why it is necessary for an astronomer to point his telescope a little in front of the star.

Those present were served with light refreshments after the close of the literary program.

A. F. Hunter,
Recorder.

NOTES FROM THE DOMINION OBSERVATORY

The technical staff of the Observatory have recently formed themselves into an Observatory Club for promoting *esprit de corps,* widening their horizon, and getting away from the Scara-lee so delightfully described by Holmes.

It is the intention to hold fortnightly informal meetings in the Observatory, Fridays from 4 to 5 p.m., at which, besides a general causerie there will be some one of the members who will give a talk on some specific subject with which he is supposedly saturated and ready to be interrogated as he proceeds. A modern blackboard is available for diagrams and illustrations.

The first meeting was held on Friday, Jan. 25, when Dr. De Lury gave a talk on "The Structure of Matter," familiarizing the members with the most recent work and investigations carried out on this great fundamental problem. Other talks that have been arranged for are:—Mr. Cannon, on "The Air Spectrum and other Spectra"; Mr. Harper, "The Interior of a Star"; Mr. Stewart, "Relativity"; Mr. Motherwell, "Variable Stars, Photographically"; Dr. McDiarmid, "Variable Stars, Visually"; Mr. French, "Some Problems in Terrestrial Magnetism"; Mr. Nugent, "Fundamental Star Places"; Mr. Jaques, "Principles of Sciences"; Mr. Hodgson, "Some Problems of Seismology"; Mr. Dier, "Wireless—The Scientific Principle and Practical Application"; Mr. Johns (a temporary volunteer at the Observatory), "The work and efforts of the United Union College at Chengtu, China."

The staff has enthusiastically entered on this new field of Observatory activity and looks forward to the promotion of their individual and collective usefulness.

O. K.

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

January, 1918

Temperature.—The mean temperature was above the average in the western and southern parts of British Columbia, and also in extreme eastern portion of Quebec and the northeast portion of New Brunswick, while in all other parts of the Dominion it was below the average. In the Western Provinces, the negative departure was very generally between 2° and 6°, while to the eastward of Manitoba the defect increased gradually until on the high lands of the Peninsula of Ontario, it was as much as 14°. Towards eastern Ontario and over Quebec the defect again diminished, and in thy Gaspé Peninsula the departure was slightly positive. In the southern portions of the Maritime Provinces the negative departure was between 2° and 6°.

Precipitation and Depth of Snow.—In British Columbia the precipitation was either average or somewhat in excess of average; on Vancouver Island and the Lower Mainland it was chiefly rain, while on the Upper Mainland it was mostly snow, which in some localities was heavy. In Alberta and Saskatchewan there were many light snowfalls, but no heavy storms, and in Manitoba the snow was quite light and less than average.

In Ontario and Quebec the precipitation was almost wholly in the form of snow, and differed little from average, except

near the shores of Lake Huron and the Georgian Bay, when it was in excess of the average,

In the Maritime Provinces there were few days of rain and many of snow, and the total aggregate amount was in defect of average, except in Cape Breton and northern New Brunswick.

At the close of the month the whole Dominion exclusive of the lower levels of British Columbia were snow covered. The greatest depth which exceeded 30 inches was in Central Ontario and in Quebec. In the southern portions of the Western Provinces there was less than 10 inches, while in the north the depth was as much as 20 inches.

Temperature for January, 1918

Station	January		Station	January	
	Highest	Lowest		Highest	Lowest
Yukon			Kenora	20	-42
Dawson	8	-50	Kinmount	26	-34
British Columbia			Kingston	35	-16
Atlin	36	-42	Kitchener	30	-10
Agassiz	51	15	London	32	-11
Barkerville	40	-22	Lucknow	30	-17
Kamloops	43	-14	Markdale	30	-21
New Westminster	54	16	North Gower	38	-26
Prince Rupert	54	20	Oshawa	30	-24
Vancouver	56	17	Ottawa	29	-26
Victoria	56	23	Paris	32	-14
			Parry Sound	25	-20
Western Provinces			Peterboro'	30	-18
Battleford	43	-46	Port Arthur	28	-30
Calgary	54	-24	Port Burwell	34	-12
Edmonton	44	-43	Port Dover	30	- 8
Medicine Hat	48	-42	Port Stanley	35	- 7
Minnedosa	33	-43	Queensborough	21	-31
Moose Jaw	44	-36	Ronville	24	-35
Oakbank	21	-42	Southampton	29	-13
Portage la Prairie	22	-37	Sundridge		
Prince Albert	40	-40	Stonecliffe	22	-36
Qu'Appelle	41	-36	Stony Creek	34	-10
Regina			Toronto	33	- 8
Saskatoon			Uxbridge	32	-17
Souris	36	-38	Wallaceburg		
Swift Current	50	-36	Welland	34	- 6
Winnipeg	22	-37	White River	19	-52
Ontario			*Quebec*		
Agincourt	33	-13	Brome	38	-42
Aurora	30	-19	Father Point	32	-14
Bancroft	25	-35	Montreal	34	-18
Barrie	31	-15	Quebec	34	-23
Beatrice	25	-20	Sherbrooke	36	-35
Bloomfield	33	-13			
Chapleau	18	-46	*Maritime Provinces*		
Chatham	35	-11	Charlottetown	42	- 8
Clinton	31	-12	Chatham	38	-26
Collingwood			Dalhousie		
Cottam	38	-18	Fredericton	36	-28
Georgetown	30	-12	Halifax	40	- 6
Goderich			Moncton	39	-19
Grimsby			St. John	38	-14
Guelph	31	-10	Sussex		
Haliburton	26	-28	Sydney	42	10
Huntsville	26	-28	Yarmouth	41	4

Earthquake Records by the Milne Seismograph

TORONTO

Sir Frederic Stupart, Director.

P.T. = Preliminary Tremors. S. = Secondary Waves. L.W. = Large Waves. A.C. = Air Currents. Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1918	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m	m	h m	h m s	h m	mm	
1803	Jan. 4			4 47·6 4 49·4	4 50·7	5 26·3	1·8	May be Guatemala
1804	" 4			16 55·3	17 04·0	17 35·8	0·6	
1805	" 12			23 34·2 23 36·9			0·1	
1806	" 13			0 04·6 0 12·4			0·2	A. C. going on.
1807	" 16			13 46·5 13 51·4	13 55·8	14 23·2	0·3	May not be seismic.
1808	" 21			20 54·1 20 58·1	21 04·8	21 23 0	0·1	
1809	" 24			15 42·8 15 50·3	15 54·2	16 30·9	0·2	Gradual thickening.
1810	" 25	1 25·6? 1 29·9	1 34·0	1 37·2 1 37·8	1 41·9	A.C.	2·4	A.C. at commencement.
1811	" 30		21 41·6		21 41·8	A.C.	1·7	Amplitude of S. waves gradually became less.

Boom period 18 seconds. Pillar inclination 1mm. = 0″·45.

VICTORIA, B. C.

F. N. Denison, Superintendent.

No.	Date 1918	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m s	h m s	h m s	h m s	h m s	mm	
1815	Jan. 4		4 46 01?	4 50 02 4 56 22	5 03 08	5 29 43	1·0	
1816	" 4	16 26 13		16 35 04	16 39 00	17 02 37	0·4	Iphase.
1817	" 12	23 48 49			23 50 18		0·2	P. may be L.
1818	" 21	20 30 21?		20 39 12?	20 47 18	21 05 46	0·3	P. may be L.
1819	" 24	15 40 12?			15 43 39	15 48 04	0·1	Iphase.
1820	" 25		1 35 35?	1 40 03? 1 45 30	1 48 28	2 18 13	0·5	S. may be P. phase. Trace indistinct.
1821	" 30	21 23 30?	21 28 32?	21 33 59?	21 37 46	22 33 00	0·5	3270 km. Repeat 22h 18m 54s.

Boom period 18 seconds. Pillar inclination 1mm. = 0″·54.

Vertical Seismograph

Date 1918	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
	h m s	h m s	h m s	h m s	h m s	μ*	*True earth movement.
Jan. 4				5 01 30		1	

J. Y.

MAGNETIC OBSERVATIONS

December, 1917

During the month of December the Magnetic Forces, as shown by the photographic records at Agincourt and Meanook were generally very little disturbed. The only disturbances of note occurred on the 16th and 18th.

The one on the 16th began suddenly at $4^h\ 13^m$ (75th M. T.) at Agincourt, and although very active no large departures were recorded until about 10 a.m. when the Horizontal Force fell rapidly about 96γ and the West Declination increased about 22′, both remained in these positions for about three hours, with no corresponding shift in the value of the Vertical Force. At 13 hours, however, the Vertical Force began to increase slowly and at 16 hours rose very rapidly about 90γ and oscillated about this value for nearly an hour and a half and then slowly returned to normal. At 16 hours the Horizontal Force also rose very rapidly, amounting to 240γ in ten minutes but it immediately began to fall with rapid oscillations and reached normal value in about an hour. At this time the Declination Curve shows no great departures from normal but at 21 hours when both H and Z curves are only moderately active, the West Declination decreased nearly 1° in 54 minutes and returned in about an hour.

At Meanook the commencement is not so pronounced and the maximum of disturbance does not coincide with the time of maximum at Agincourt. The largest departures in Declination were from 3 hours to 5 hours, (105th M. T.) and the range 1° 33′. The remainder of the disturbance was quite active but the oscillations were of small amplitude.

The disturbance on the 18th began suddenly at $23^h\ 47^m$ (75th M.T.) at both places. The greatest activity also occurred simultaneously at both places at 5^h (75th M.T.), at Agincourt in 50 minutes the Horizontal Force decreased 216γ, the Vertical Force decreased about 220γ and West Declination increased 38′ and at Meanook East Declination decreased about 1°. In each

case the Forces were about normal again at 8 hours and the disturbance over about noon.

AGINCOURT MAGNETIC OBSERVATIONS

Lat. 43° 47′ N.; Long. 79° 16′ W.

December, 1917		D. West	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	6 37·9	15936	58433	74 44·7
	Maximum	7 17·9	16167	58645	
	Date of Maximum	18	16	16	
	Minimum	5 46·2	15647	58207	
	Date of Minimum	16	18	18	
	Monthly Range	1 31·7	520	438	
Mean Daily Amplitude	From hourly readings	7·2	38	19	
	From means of extremes	18·3	76	36	

MEANOOK MAGNETIC OBSERVATIONS

Lat. 54° 37′ N.; Long. 113° 21′ W.

December, 1917		D. East	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	27 46·0	12936	60530	77 56·2
	Maximum	28 57·0			
	Date	16			
	Minimum	26 32·1			
	Date	16			
	Monthly Range	2 24·9			
Mean Daily Amplitude	From hourly readings	7·3			
	From means of extremes	22·6			

H and Z are given in Gammas. (1 γ = 0·00001 C.G.S.).

All results are reduced to International Magnetic Standard.

The value for I at Meanook is the mean of all the observations made during the month without regard to the time of day.

The value of H at Meanook is the mean of two observations made about the middle of the month, and the Z is obtained by the formula Z = H tan I.

W. E. W. J.

ASTRONOMICAL NOTES

DISCOVERY AND INVENTION.—Scientific research in physics and chemistry is of two kinds: one kind deals with the nature of the phenomena observed, and endeavors to arrive at some soul-satisfying explanation of the why and wherefore of the particular occurrence; the other endeavors to discover hitherto unknown phenomena. Naturally the earlier investigations dealt with known phenomena, and one type of discovery consisted in determining its laws. Newton's discovery of the laws of gravitation dealt numerically with the fall of matter from a height, and applied equally to the motion of worlds and the fall of a stone. The facts were known, and the discovery consisted in the determination of the law of the fall and the measurement of a pull at any distance—a few feet or thousands and millions of miles. The discovery, however, of a numerical law does not constitute an explanation of a phenomenon. Gravitation is as great a mystery now as in Newton's day; no explanation has been forthcoming, no possible mechanism has been conceived to enable us to understand the nature of the attraction of one particle of matter for another, either at atomic distances or at the huge gaps of interstellar space. Newton's discoveries supplied the law, but not the explanation. So far science has often been able to supply the law, but never the explanation. Many laws are known with considerable accuracy, but all reasoning on the facts leads up to the contradiction which inevitably follows the closer application of thought to theories of gravitation, cohension, light, electricity, chemical action, and life; all appear equally inexplicable. The object of the more highly abstract scientific investigation is to find some reasonable explanation of the uni-

verse, and this can only be attempted by the close examination of all phenomena and the discovery of phenomena hitherto unknown, then the determination of such laws as can be dealt with by the senses with which Providence has gifted us, aided by the use of special instruments to extend their scope.

The knowledge of the physical and chemical properties of the elements which had thus accumulated led to the wonderful discovery of Newlands in 1863, followed that of Mendeleeff in 1869, that the elementary bodies when arranged in order of atomic weight showed a distinct periodicity of properties, so that the elements could be divided into groups of eight of ever-increasing atomic weight with constantly recurring properties. This variation is shown most clearly by Professor Richards in curves of the properties of thirty-five solid elements. The properties chosen are melting points, co-efficients of expansion, atomic volumes and compressibilities. So accurate is this periodicity that Mendeleeff predicted the existence of unknown elements because of certain gaps in his tables, and the elements were discovered later, and they possessed the properties proper to their place. The existence of this periodicity suggests a common origin for all the elements, that the elements are in fact built up from some one substance of low atomic weight. This hypothesis was somewhat crudely stated by William Prout, a chemist and physician, at the end of the eighteenth century.

The discovery of radio-activity by Becquerel, and the separation of radium salt by Madame and Professor Curie, supplied Rutherford, Soddy and Ramsay the basis for investigations which proved the existence of atoms, or, rather, so-called atoms, which disintegrate spontaneously and form many other bodies. This, with the brilliant work of Sir J. J. Thomson, proved the existence and properties of a unit body called the electron, which body could be detached from any gaseous atom by electric discharge *in vacuo*. This suggests that there is some truth in the idea of the ultimate unity of all matter. This hypothesis may yet throw startling light upon the ultimate constitution of matter, the nature of electricity and the nature of mass, and even give a

key to the nature of gravitation at present so entirely inexplicable. Sir William Crookes, as early as 1886, discussed the strange periodicity of the elements in connection with a possible unity of origin at a meeting of the British Association.—Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., M.Inst.C.E., *English Mechanic and World of Science*, Nos. 2751 and 2752.

The Sun's Heat.—The measurement of the solar constant, the total intensity of solar radiation outside the earth's atmosphere at the earth's mean distance from the sun, as made by the observers of the Smithsonian Institution at the Washington, Mount Wilson and Mount Whitney stations, is 1·95 calory per square centimetre per minute and it is thought that future investigation will make no considerable change in this value. The amount of energy represented by this radiation is difficult of conception. Assuming, as we have reason to do, that the sun radiates equally in all directions we can easily calculate the total emission, as it is 1·95 calory per minute on each square centimetre of a sphere whose radius is the mean distance of the earth from the sun, that is, 93,000,000 miles or 15×10^{12} centimetres.

Total emission = $1{\cdot}95 \times 4\ (15 \times 10^{12})^2$ calory per minute. This is sufficient, as Abbot calculates, to melt a layer of ice 426 feet thick in a year. A layer 426 feet thick over the cross-section of the earth is equivalent to a layer 106·5 feet over its surface, so that we can say that the heat received by the earth in a year is sufficient to melt a surrounding shell of ice 106·5 feet thick. Abbot further calculates that the melting in a year of a shell of ice 426 feet thick surrounding the sun at the earth's mean distance would represent as many heat units as the burning of 4×10^{15} tons of anthracite coal or a mass of coal 60 times the mass of the earth.

The great terrestrial sources of heat are combustion and the transformation into heat of electrical energy obtained from water power. If we try to account for the sun's heat by combustion we reach an absurdly small result for the life of the sun. We

have just seen that the yearly output of heat is equivalent to that from the burning of 4×10^{23} tons of coal. If the sun were composed of pure coal its combustion would supply the heat loss only for $\frac{2{\cdot}19 \times 10^{27}}{4 \times 10^{23}} = 5{,}500$ years, a moment only in the life history of the sun-earth system.

It has been suggested that the maintenance of the solar radiation is due to the continued fall of meteoric matter into the sun. A mass coming from an infinite distance would acquire a velocity of 610 kilometres or 385 miles per second at the surface of the sun and when brought to rest would disengage 6,000 times as much heat as would be produced if it were coal burning in oxygen. To compensate for the loss of radiation would require that 22 pounds of matter fall upon each square yard of the sun's surface per hour. This would increase the diameter of the sun so slowly that 35 millions of years must elapse before the increase would attain one second of arc. It would, however, increase the mass of the sun to such an extent that the effect could not escape detection. Bosler calculates that in the last 2,000 years the accumulation would have been sufficient to change the orbital motion of the Earth by $\frac{1}{8}$ of a year, a change, needless to say, that has not occurred. Moreover, few meteors coming from interstellar space would fall into the sun as most of them would circulate around it as comets do.

A source of heat that has been very generally admitted since its suggestion by Helmholtz, is the gravitational attraction of the sun upon its own material, as a gradual falling of the sun's substance toward the centre would transform the potential energy of gravitation into heat. The estimates of the energy available in the past from this source are based upon the contraction of the sun to its present size from a diameter exceeding that of the orbit of Neptune, the outermost known member of the solar system. The energy supplied by this contraction would have sustained the present rate of radiation for approximately 25,000,000 years. According to Newcomb the sun will have shrunk to half its present diameter in 7,000,000 years and will

be unable to furnish heat sufficient to support life as we know it for more than 15,000,000 years.

Though the gravitational contraction of the sun is regarded as a real source of energy, it is generally admitted that it alone is not sufficient to account for radiation through the enormous periods of time required for the geological transformation of the earth. In the effort to meet this recognized difficulty the suggestion has been made that the solar radiation was less intense during past ages than at present, the deficit being supplied by the inherent heat of the earth or by receiving heat from a large solid angle subtended by a greatly extended nebular sun. And since the discovery of the liberation of energy by the breaking up of radio-active substances, much attention has been given to the suggestion that the presence of such substances in the sun would assist in maintaining the solar radiation and give it sufficient duration to meet the requirements of geological transformation. Direct proof of their presence in the sun is lacking, though the occurrence of helium in the sun, a product of the disintegration of radium, may be taken as indicative of their possible presence. That the lines of radio active elements do not occur in the solar spectrum is not surprising in view of their high atomic weights. If radium and its parent element, uranium, do exist in the sun, they are probably at a very low level in the solar atmosphere and their lines would consequently be extremely faint or absent. The whole question is one of extreme difficulty and has not as yet received a satisfactory solution.—C. E. St. John, *Pub. Ast. Soc. Pacific*, February, 1918.

Results of Observation of Radial Velocities of Central Part of Andromeda Nebula.—The radial velocity of the nebula is − 316 km., a value in good agreement with the earlier measures. The linear velocity of rotation at a point 2′ of arc from the nucleus is 58 per sec. Within the distance measured and the limits of accuracy of the measures the change of rotational velocity with distance seems to be linear, although there may be variations at individual points in the nebula. Whether the motion of the nebula is inward or outward along the arms of the spiral depends upon the inclination of the nebula.—F. G. Pease. *Proc. Nat. Acad. Sciences, U.S.*, January, 1918. J. R. C.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries.

'DAYLIGHT SAVING;' IS IT COMING?

A year ago the proposal to introduce 'daylight saving' into Canada was laughed out of the House of Commons, but it looks now as though we may have it after all. A bill has passed the United States Senate and, it is said, is likely to be accepted by the House of Representatives and the President, providing for the change in the clocks. There is a great agitation going on in the United States in favor of the proposal and Canadian newspapers also are advocating it. It is not a new thing. In 1907 a pamphlet entitled "The Waste of Daylight" was published in England by a man named Willett, but the subject was discussed many years before,— by Benjamin Franklin, indeed.

To many the suggestion to move on the clock and use the sunlight appears ridiculous. Why not get up earlier? But we are simply slaves to the clock, and if by advancing the hands one hour we shall automatically rise earlier and do our work by daylight instead of taking much of the night for it, by all means let us do it.

Early in the war Germany adopted daylight saving and since then the following countries have done the same:—Italy, Portugal, Sweden, Norway, Denmark, Holland, Belgium, Austria and Australia and, perhaps, others. At the present time when we are so short of coal and electric energy the scheme of daylight saving is a real conservation measure.

In explaining the measure, U. S. Senator Calder stated:—

Briefly the bill provides that at 2 o'clock a.m. on the last Sunday in April of each year, the clock will be advanced one hour; that is, the hands of the clock will be turned on to 3 o'clock, and on the last Sunday in September of each year at 2 o'clock a.m. the hands of the clock will be turned back one hour.

The purpose of the bill is to move the day one hour earlier during the summer months, thereby making use of one hour of daylight ordinarily wasted in the early morning. I wouldn't be surprised if when the matter comes to the consideration of the House an amendment might be suggested changing the dates, and instead of making it operative for only five months of the year an additonal month of the daylight saving system might be fixed at both ends of the daylight saving season, making it altogether seven months instead of five.

RISING HOURS LATE

Perhaps 95 per cent of the adult population of America rises in daylight and retires in darkness during the summer months. With this measure in effect there will be just one hour more of daylight while we are awake and one hour less of darkness. There's nothing intricate about it. Railways will move on the same schedules at the same clock time. They will not even have to be reprinted, except as other changes than those of time necessitate it. Foredated engagements will be kept, and the world, 95 per cent. of which will be asleep when the change of time is made, will never realize it.

Every important nation in Europe, with the exception of Russia, has adopted this scheme of giving to work and to play more time in the bright hours of the twenty-four. It has worked successfully in every one of them. It has given the workingman one extra hour of daylight recreation or for the little labors about the home, such as gardening and repair work, if his inclinations are in that direction. Great Britain gave it a trial in 1916. Great Britain is conservative. The British Government took no chances with the possible popularity of the measure and left it to proof, but the proof was forthcoming, for in 1917 the system was restored as a beneficial step.

A MEASURE OF CONSERVATION

It is interesting to note the effect the adoption of this bill would have economically. In these war times it is of supreme importance that we should conserve everything, and what is more important than that the time of the worker should be conserved? The substitution of an hour of daylight for an hour of darkness is the thing we conserve in this. At this very moment the country is in the midst of a coal shortage, a very serious shortage. This is one way to help that situation in the matter of the fuel consumed in creating artificial light. It is no fad at all. It is a practical common sense measure.

When the Senate Committee on Interstate Commerce first reported the Calder bill last May and recommended that it pass

it gave three fundamental reasons for a favorable report. It accepted recommendations of the advocates of the measure upon the following grounds:

First—It is fairly calculated to accomplish valuable economies in our national life.

Second—The comfort and convenience of many millions of our people will be promoted by its passage.

Third—It is regarded as of special value in the present national emergency.

Of course the change will be an inconvenience to the astronomer and more especially to the meteorologist, but if it will add to our national efficiency, the scientist will gladly accept the new conditions.

A "PILLAR OF LIGHT," AND ITS POSSIBLE EXPLANATION

In the minutes of a meeting of the Society reported on page 61 of last month's JOURNAL, reference was made to a peculiar "pillar of light" seen in the sky at the time of a fire in a pattern works in Toronto. I was pleased to receive a letter from Dr. John A. Brashear, written while confined to the house by a fall on the ice, in which is offered an explanation of this phenomenon. It may be stated that the "pillar" was a very definite cylinder vertically in the sky where it remained quite steady for some time— half an hour at least. It was seen by the writer from a point about three-quarters of a mile from the fire. It was in the direction of the fire and about 45° in altitude. The length of the pillar was about 6° or 8°.

I quote from Dr. Brashear's letter:—

Just after the discovery of natural gas in western Pennsylvania many wells were bored, and gas was found, but no provision had been made to conserve it. In many wells the pressure was so great,—in some cases 700 pounds to the square inch,—that it was impossible to hold the pressure in the pipes by valves or by plugging, so the only way at the time was to let the gas

"OBSERVATORY HILL, B.C."

When the new astrophysical observatory was located in British Columbia its site was known as Little Saanich Mountain, but henceforth it will go down to fame as Observatory Hill. The change was made by the Geographical Board of Canada, at the suggestion of Dr. J. S. Plaskett. At the same time Big Saanich Mountain, a little to the west, had its name changed to Mount Wark, a name associated with the early history of the city of Victoria.

I learn also that the spectroscope has been placed in position on the great reflector.

C. A. C.

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